Global Scientific JOURNALS

GSJ: Volume 12, Issue 2, February 2024, Online: ISSN 2320-9186
www.globalscientificjournal.com

Assessment of the Contribution of Motor Vehicle Emissions to Air Pollution in Jimeta Area of Yola Metropolis, Adamawa State, Nigeria

Ibrahim Abubakar Adamu[1], Saadatu Musa Yerima[1] & Enoch Buba Badgal[2]

[1]Department of Disaster Management, Adamawa State Polytechnic Yola, Adamawa, Nigeria
[2]Department of Forestry Technology, Adamawa State Polytechnic Yola, Adamawa, Nigeria

Correspondent Email: ibrahimabubakaradamu247@gmail.com

Abstract

The study assesses the contribution of motor vehicle emissions to air pollution in Jimeta metropolitan area, Adamawa state, Nigeria. The objectives of the study were to measure and compare with NESREA standard safe limit, the concentration of CO, NO_2 and SO_2 in the ambient air and to further determine the relationship between the concentration levels of the pollutants and traffic volume in the study area. Four hotspot locations were studied within the months of March to August 2023 (Three months dry season and three months wet season) using Crowcon Gasman portable single gas detector devices. The sampling was carried out once a week in each of the six months at all sampled points, three times a day. The results show that the mean concentration of NO_2 (0.12 – 0.85 ppm) and SO_2 (0.07 – 0.24 ppm) in all sampled points has exceeded the Nigerian National Ambient Air Quality Standards limit, while the mean concentration of CO (5.62 – 9.34 ppm) was below the standard limit at all the sampled points except in some locations like Jimeta main market, Kasuwan gwari and shopping complex gate in the morning and evening peak periods (10.30 – 12.01 ppm). The study also reveals that the concentrations of gaseous pollutants in the dry season were slightly higher than the concentrations in the wet season. The study further reveals insignificant relationship ($p > 0.05$) between CO ($r = 0.558$), NO_2 ($r = 0.169$) and SO_2 ($r = -0.572$) and the traffic volume. The study recommends regular maintenance of vehicles and rehabilitation of roads; motorization growth should be largely checked and patronage of mass transit should be encouraged.

Keywords: Air pollution, CO, NO_2, SO_2, Motor vehicle emission, NESREA, Jimeta metropolis

1.0 Introduction

No doubt, that one of the basic requirements of human existence is clean air, but air pollution has continued to pose a significant threat to this basic human need and environmental health worldwide (Hassan & Abdullahi, 2012). Air pollution is a contamination of the indoor and outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere (WHO, 2011). Air pollution is mainly caused by four main sources: automobile exhaust, industrial activity, home cooking and smoking. This pollution can harm humans, other living things like food crops, or the environment. Nevertheless, the extent of air pollution depends on the country's technological progress and air pollution control measures (Nkwocha et al., 2017).

Although there are many other sources of pollution in the urban environment, current observations have shown that the rapid increase in the use of vehicles for day-to-day transportation in most developing countries, coupled with a lack of emission standards in these countries, has contributed a great deal of concern over vehicular pollution (Suh et al., 2017). According to the United States Environmental Protection Agency (USEPA, 2017), motor vehicles account for 10 % of particulate matter (PM), 34 % of nitrogen dioxide (NO_2), and 51 % of carbon monoxide (CO) released yearly in the US. Similarly, the World Health Organization, WHO (2001) has identified motor vehicles as one of the major leading causes of air pollution in most urban cities of the world, though China, the United States, Russia, Mexico, and Japan are the world leaders in air pollution emissions. Motor vehicles in developing countries cause serious air pollution due to their concentration in a few large cities, besides, many are in poor mechanical conditions since they are mostly second-hand vehicles imported from other countries. Vehicular emissions are expected to increase reasonably as automobile ownership increases globally (Abam & Unachukwu, 2015). This clearly indicates that motor vehicle emission is a major source of air pollution in both developed and developing countries.

Air pollution due to vehicular emission remains a threat to the environment and health-related problems which are expected to increase rapidly as per capita vehicle ownership increases around the world (WHO. 2000; Abam & Unachukwu, 2015). Exposures to common air pollutants have been linked to a wide range of adverse health outcomes, including fatigue, headaches, dizziness, loss of consciousness, respiratory and cardiovascular diseases, asthma exacerbation, reduced lung function and premature death (Gulliver & Briggs, 2011; WHO, 2011; Brezzi & Sanchez-Serra; 2014).

Changes in the seasons or time of year have been noted to have an impact on the air quality that has been observed because they may affect how well air pollutants disperse by affecting the concentration of those pollutants in the atmosphere, which may be reduced or increased. Difference in the ambient temperature, relative humidity and wind speed including wind direction could also vary the concentration of atmospheric pollutants over the seasons (Kim et al., 2015). Especially, in this region of the world, where there are two distinct seasons, the atmospheric pollutants may vary spatially. For example, during the dry season, when the relative humidity is moderately low and the wind velocity is higher, the pollutants have a higher tendency to be swiftly dispersed. As noted by Mauss (2017), air pollutants are dispersed more during the dry season than during the wet season.

Many studies such as Ibe et al. (2016); Modinah et al. (2019) and Vivan et al. (2013), conducted in Imo, Lagos, and Abuja respectively, have documented adverse health effects associated with high concentrations of transport-related pollutants. The studies concluded that the high concentrations of pollutants recorded in the study locations call for concern and may pose environmental health challenges in the area. This study assesses the contribution of motor vehicle emissions to air pollution in Jimeta metropolitan area, Adamawa state, Nigeria. The objectives of the study were to measure and compare with NESREA standard limit, the concentration of CO, NO_2 and SO_2 in the ambient air and to further determine the relationship between traffic volume and the concentration levels of the pollutants in the study area.

Hypothesis:

H_0: There is no significant relationship between the air pollutants and traffic volume at the sampled points.

1.1 National Ambient Air Quality Standards of Nigeria

The required standard limits set by FEPA and NESREA were established for pollutants that are harmful to public health and/or the environment (Asheshi, 2012). According to the Federal Ministry of Environment Nigeria, (2016), the standards are applicable to the possible air pollutants that were determined from scientific evidence, a review of existing regulations, standards and codes, especially the Nigerian Ambient Air Quality Standards. The National Environmental Standards and Regulations Enforcement Agency (NESREA, 2009) and Federal Environmental Protection Agency (FEPA, 1991) developed the ambient air quality standards for Nigeria articulated in accordance with WHO air quality standards. The table below shows the Nigerian ambient air quality standards for conventional air pollutants:

Table 1.1: Nigerian National Ambient Air Quality Standard

Pollutants	Average Time	Air Quality Standard Guideline Value
Particulate Matter (PM)	1 Hour	250 åg/m^3
Sulfur Dioxide (SO2)	1 Hour	0.01 ppm (260 åg/m^3)
	24 Hours	0.1 ppm(0.0282 åg/m^3)
Nitrogen Dioxide (NO2)	I Hour	0.04 pm (22.8 åg/m^3)

	24 Hours	0.06 ppm (0.112 åg/m^3)
Carbon Monoxide (CO)	1 Hour	10 ppm (11.4 åg/m^3)
	8 Hours	20 ppm (24.7 åg/m^3)
Hydrocarbon	3 Hours	0.6 ppm
Photochemical Oxidants	1 Hour	0.04 ppm – 0.06 ppm

2.0 Materials and Methods

2.1 Study Area

Jimeta is a densely populated urban core and its less-populated surrounding areas located in Adamawa state, in the Northeastern part of Nigeria (Figure 1). It was founded in 1914, by colonial masters, as a model town of greater Yola (Aminu & Ibrahim, 2015). It is situated between latitude 9° 11'N - 9° 19'N and longitude 12° 12'E - 12^0 28'E. Jimeta is bordered by Girei LGA, to the north, Yola south LGA, to the west, south, and east (Adebayo et al., 2012). With a land area of 111.85 square kilometres and a total population of 198,314 based on 2006 National population census, the study area is characterized by high population growth of 2.83% and rapid sprawl of about 7%. The population of the metropolis was projected to year 2023 with an annual growth rate of 2.83% and placed at 318,593. Zemba et al. (2013) observed that the reason for the concentration of the population is linked to the fact that the area serves as an administrative centre of the state. Jimeta metropolis consists of eleven administrative wards. Namely: Ajiya, Alkalawa, Doubeli, Gwadabawa, Jambutu, Karewa, Limawa, Luggere, Nassarawo, Rumde and Yelwa ward.

Jimeta comprises many land use types ranging from institutional, agricultural, and commercial to residential. It is stratified into low, medium and high-density areas. The low-density areas are well-planned units where government officials reside, while medium and high-density areas are made up of common people with little or unplanned buildings (Abdullahi, 2018). Jimeta is considered a both an administrative and commercial centre. The commercial status of the city grows with the increase in population, development, and financial institutions, small and medium-scale manufacturing industries which resulted in the stimulation of commercial activities. The study area has a tropical wet and dry climate. Dry season lasts for a minimum of five months (November-March) while the wet season spans from April to October (Adebayo & Zemba, 2020). The vegetation is grassland with few trees supported by the thin soil or scree from the rocky slopes. Oftentimes, the trees grow through cracks or fractures in rocks enhancing their disintegration (Aliyu et al., 2013).

Jimeta, is one of the fastest-growing cities in northeast Nigeria. It is a center of economic, social and political development as well as industrial and commercial activity (Aliyu & Amadu, 2017). Thanks to this development, people continue to flow into the town in search of greener pastures. Along with rising income levels, this influx of people, combined with the growing desire of individuals to move from one place to the other, has led to a significant increase in car ownership and transportation. This has led to an increase in the number of vehicles on the highways, contributing to cumulative air pollution from emissions from these vehicles. Over the years, commercial traffic within the town has changed from the use of motorcycles and buses to the use of tricycles (popularly known as keke Napep) and the number of these tricycles is increasing in an alarming rate causing increase in gasses emissions within the metropolis.

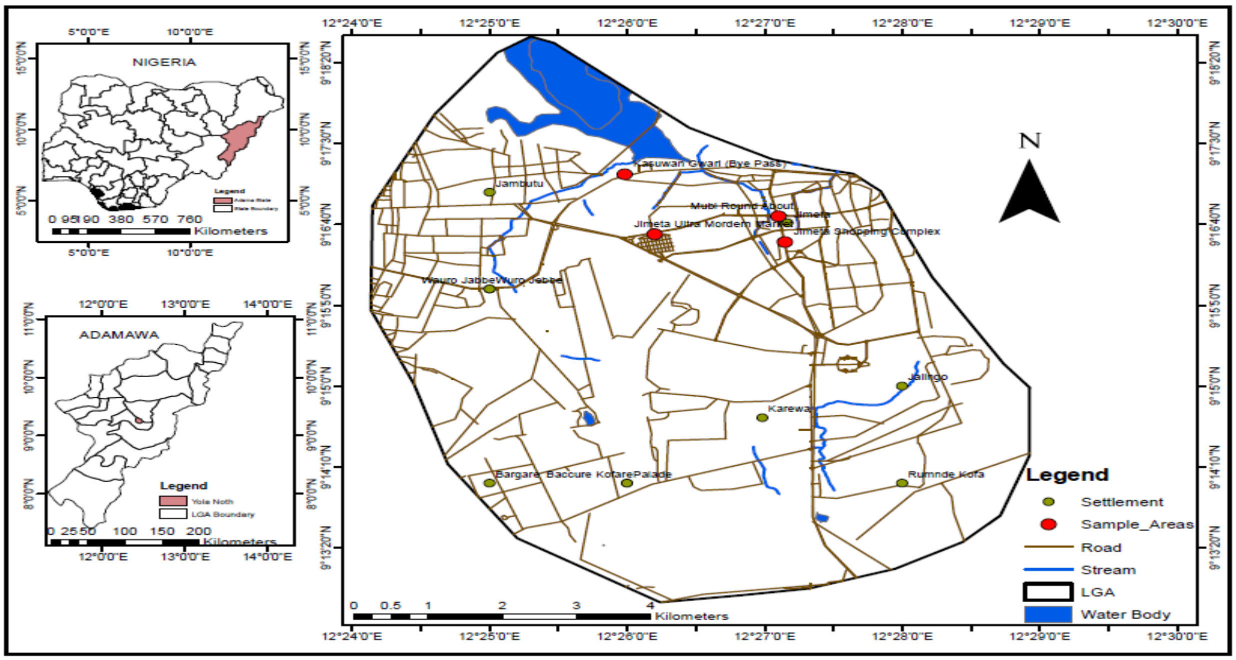

Figure 1: Map of Jimeta showing the four sampled points

Source: Modified from the Administrative Map of Adamawa state

Table 2.1: Air quality sampled sites and their characteristics

Location	Latitude	Longitude	Elevation	Characteristics
Jimeta Modern Market Gate	$9^0$16′34″N	$12^0$26′12″E	169 m	High vehicular traffic, shops, market residential and commercial buildings.
Kasuwan Gwari (Bye pass)	$9^0$17′11″N	$12^0$25′59″E	162 m	High vehicular traffic, human concentration, potholes, market, residential and commercial buildings.

Mubi Roundabout	$9^0$16′45″N	$12^0$27′06″E	163 m	High vehicular traffic, shops and commercial buildings.
Shopping Complex Gate	$9^0$16’29″N	$12^0$27′09″E	168 m	High vehicular traffic, human concentration, shops, market and residential and commercial buildings.

Source: Author, 2023

2.2 Air Quality Sampling Procedure

The air pollutants CO, NO_2 and SO_2 were sampled three times a day; morning (7:30 – 9:30 am), afternoon (12:30 – 2:30 pm) and evening (4:30 – 6:30 pm) with Gasman Crowcon single pollutant detector (Model CE89/336/EEC, Crowcon Instrument Ltd. England). The sampling was carried out for six months during wet and dry seasons between the months of March and August 2023. The sampling was carried out once a week at each of the four air monitoring hotspot locations, three times per day, four times a month for a period of six months as mentioned earlier. To measure a specific air pollutant, the Crowcon gasman detector switched on and held at about 2m above the ground level, and then the concentration will be recorded automatically and read on the digital display when the reading becomes stabilized.

In order to determine the traffic volume, traffic count was manually done, counting the vehicle movement in and out on the road for 30 minutes at each sampled period. 30 minutes was selected in consideration of the size of the town in order to avoid repetition of vehicle movement. The air pollutants measurement and the traffic counts were conducted simultaneously, three times per day, once a week, and four times per month for the period of six months in all the four sampled points within Jimeta metropolis.

2.3 Method of Data Analysis

Mean concentration of air pollutants CO, NO_2 and SO_2 and the average traffic volume at all the sampled points and periods were computed using Microsoft Excel 2010 edition and Statistical Package for Social Sciences (SPSS) version 21.0. Pearson correlation was used to ascertain the relationship between the air pollutant concentrations at the sampled points and the traffic volumes.

3.0 Results

3.1 The Mean Concentration Level of Pollutants and Traffic Volume for Dry Season

The result in Table 3.1 indicates that the mean values of CO in all four sampled points for the dry season ranged from 8.12 – 11.33 ppm, 5.34 – 9.47 ppm and 9.43 – 12.33 ppm for morning, afternoon and evening periods respectively. The mean concentration of NO_2 in all four sampled stations ranged from 0.25 – 0.41 ppm, 0.12 – 0.54 ppm and 0.31 – 1.12 ppm for morning, afternoon and evening periods respectively, while the mean values of SO_2 in all four sampled points ranged from 0.07 – 0.17 ppm, 0.09 – 0.21 ppm and 0.08 – 0.24 ppm for morning, afternoon and evening periods respectively. The Table also shows the average traffic volume in all four sampled points ranging between 577 – 1967, 532 – 1624 and 845 – 2101 for morning, afternoon and evening periods respectively.

Table 3.1: Mean gas emission and average traffic volume for dry season

	Traffic Volume			**CO (ppm)**			**NO_2 (ppm)**			**SO_2 (ppm)**		
	M	**A**	**E**	**M**	**A**	**E**	**M**	**A**	**E**	**M**	**A**	**E**
Jimeta Main Market Gate	1967	1624	2101	10.72	9.11	11.39	0.36	0.24	0.51	0.09	0.11	0.10
Kasuwan Gwari	894	729	845	11.33	9.47	12.33	0.41	0.54	1.12	0.07	0.09	0.08
Mubi Roundabout	577	532	857	8.12	5.46	9.43	0.29	0.12	0.32	0.14	0.21	0.18
Shopping Complex Gate	1008	623	1026	8.70	5.34	10.17	0.25	0.18	0.31	0.17	0.20	0.24

M = Morning **A** = Afternoon **E** = Evening

Source: Field survey, 2023

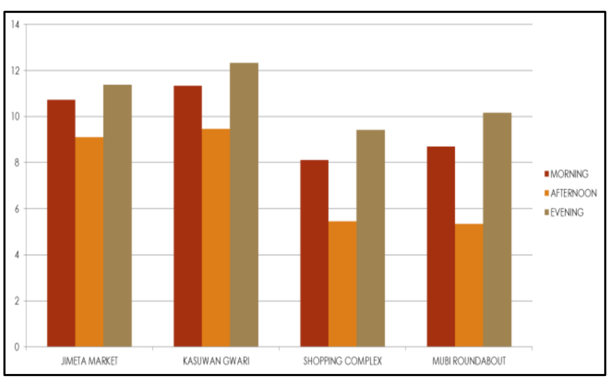

Fig. 3.1: Concentration Level for CO (Dry Season)

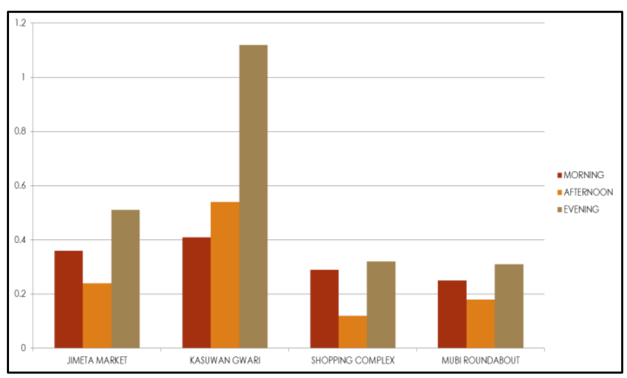

Fig. 3.2: Concentration Level for NO_2 (Dry season)

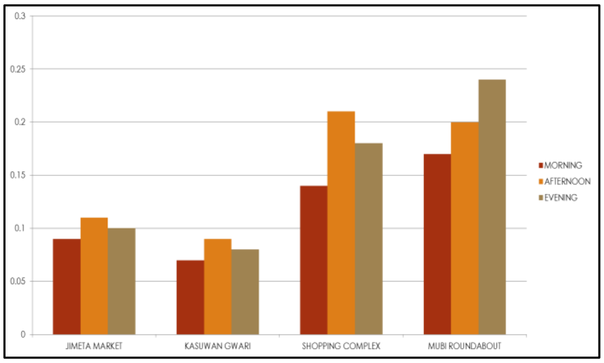

Fig. 3.3: Concentration Level for SO_2 (Dry Season)

3.2 The Mean Concentration Level of Pollutants and Traffic Volume for Wet Season

The result in Table 3.2 shows that the mean values of CO in all four sampled points for the wet season ranged from 8.51 – 11.48 ppm, 6.12 - 9.27 ppm and 8.82 – 12.68 ppm for morning, afternoon and evening periods respectively. The mean concentration of NO_2 in all the four sampled stations ranged from 0.29 – 0.38 ppm, 0.12 – 0.29 ppm and 0.32 – 0.58 ppm for morning, afternoon and evening periods respectively while the mean values of SO_2 in all four sampled points ranged from 0.07 – 0.18 ppm, 0.09 – 0.19 ppm and 0.09 – 0.24 ppm for morning, afternoon and evening periods respectively. The table also shows the average traffic volume in all four sampled points ranging between 518 – 1842, 478 – 1785 and 445 – 2144 for morning, afternoon and evening periods respectively.

Table 3.2: Mean gas emission and average traffic volume for wet season

	Traffic Volume			CO (ppm)			NO_2 (ppm)			SO_2 (ppm)		
	M	**A**	**E**	**M**	**A**	**E**	**M**	**A**	**E**	**M**	**A**	**E**
Jimeta Main Market	1842	1785	2144	10.18	9.27	11.52	0.37	0.25	0.51	0.09	0.12	0.09
Kasuwan Gwari	696	710	900	11.48	9.20	12.68	0.38	0.29	0.58	0.07	0.09	0.15
Mubi Roundabout	518	478	445	8.51	5.77	8.82	0.30	0.12	0.32	0.16	0.22	0.15
Shopping Complex Gate	629	554	551	8.92	6.12	10.43	0.29	0.18	0.32	0.18	0.19	0.24

M = Morning **A** = Afternoon **E** = Evening

Source: Field survey, 2023

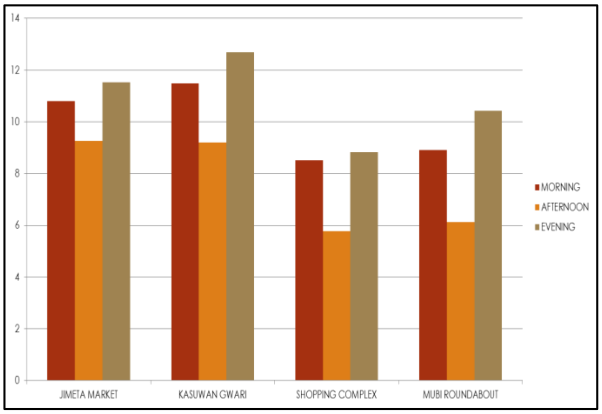

Fig. 3.4: Concentration Level for CO (Wet Season)

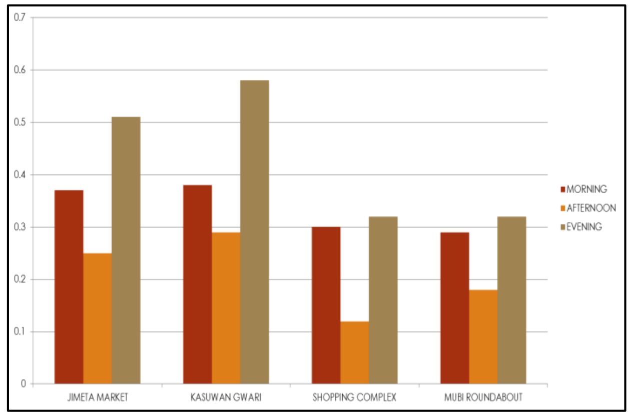

Fig. 3.5: Concentration Level for NO_2 (Wet Season)

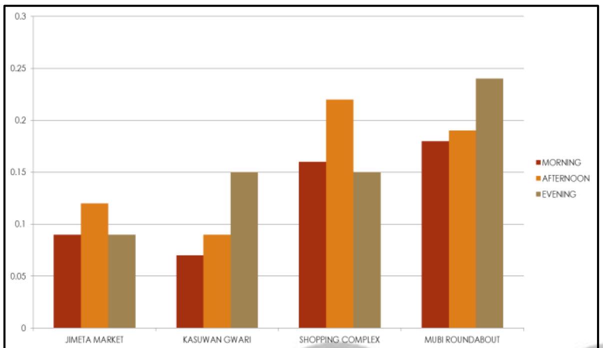

Fig. 3.6: Concentration Level for SO_2 (Wet Season)

3.3 The Cumulative Mean Concentration Level of Pollutants and Traffic Volume for both Dry and Wet Seasons in all the Four Sampled Points

The result in Table 3.3 indicates that the cumulative mean values of CO for both seasons in all four sampled points ranged from 8.32 – 11.45 ppm, 5.62 - 9.34 ppm and 9.13 – 12.01 ppm for morning, afternoon and evening periods respectively. Also, the mean concentration of NO_2 in all four sampled stations ranged from 0.27 – 0.40 ppm, 0.12 – 0.42 ppm and 0.32 – 0.85 ppm for morning, afternoon and evening periods respectively while the mean values of SO_2 in all the four sampled points ranged from 0.07 – 0.18 ppm, 0.12 – 0.22 ppm and 0.10 – 0.24 ppm for morning, afternoon and evening periods respectively. The table also shows the average traffic volume in all four sampled points ranging between 548 – 1905, 505 – 1705 and 651 – 2123 for morning, afternoon and evening periods respectively.

Table 3.3: Mean pollutants concentration and average traffic volume for both seasons at four sampled points

	Traffic Volume			CO (ppm)			NO_2 (ppm)			SO_2 (ppm)		
	M	A	E	M	A	E	M	A	E	M	A	E
Jimeta Main Market Gate	1905	1705	2123	10.45	9.19	11.46	0.37	0.25	0.51	0.09	0.12	0.10

Kasuwan Gwari	795	720	873	11.41	9.34	12.01	0.40	0.42	0.85	0.07	0.09	0.12
Mubi Roundabout	548	505	651	8.32	5.62	9.13	0.30	0.12	0.32	0.15	0.22	0.17
Shopping Complex Gate	818	589	789	8.81	5.74	10.30	0.27	0.18	0.32	0.18	0.20	0.24

M = Morning **A** = Afternoon **E** = Evening

Source: Field survey, 2023

4.0 Discussion

The result in Table 3.3 shows that the mean CO concentrations were elevated in both dry and wet seasons in Jimeta main market gate and kasuwan gwari in morning and evening periods, and in shopping complex gate in the evening period. It can also be observed that the higher concentrations of CO were obtained in the evening periods and slightly declined in the morning periods, while lower below 10 ppm in the afternoon in almost all the locations.

The highest mean concentration of CO for all stations was observed at kasuwan gwari in the evening period in both dry and wet seasons with 12.33 ppm and 12.68 ppm respectively. This implies higher commercial and other anthropogenic activities responsible for the emission of this air pollutant (CO). Possibly as a result of the higher concentration of motor vehicles during these peak periods, coupled with the dilapidation of the road which in most of the time causes traffic congestion.

Therefore, the records from these two locations (Kasuwan Gwari and Jimeta main market) were found to be above the safe limits of 10 ppm (I hour limit) set by NESREA's Ambient Air Quality Standard in the mornings and evenings. This means that the air quality standards in terms of CO were unhealthy for the public working or living around the area. The high concentration of CO in the two locations could be attributed to heavy traffic congestion and slow movement of vehicles, fossil fuel combustion, especially from vehicles and other engines. The mean concentration of CO in the two locations in the afternoon periods was found to be below the NESREA standard limit (9.19 – 9.34 ppm).

The mean concentration of CO in Mubi roundabout and shopping complex was found to be below the NESREA standard limits (5.62 – 9.12 ppm) in almost all the periods except at shopping complex in the evening periods (10.30 ppm) which was found to be slightly above the NESREA lower limit. This shows that the air at the two locations was fresh and had not been saturated by emissions from a higher concentration of vehicles, making the air quality in terms of CO is healthy with little or no health concerns to the people working or living around the area.

This result was similar to the findings by Maitera et al. (2018) who reported a high concentration of CO during the morning and evening periods in Yola metropolitan area of

Adamawa state. However, the result contradicts the findings by Modinah et al. (2019), who found that the level of CO measured at all the sampled points was below the NESREA permissible limit in the Ilorin-Lagos expressway. CO is a colorless, odorless gas that can be harmful when inhaled in large amounts. CO is released when something is burned. It is produced in the incomplete combustion of carbon-containing fuels, such as gasoline, natural gas, oil, coal, and wood. The greatest sources of CO to outdoor air are cars, trucks and other vehicles or machinery that burn fossil fuels. It is no doubt that a moderate correlation at 0.05 confidence levels between the mean CO and traffic volume at all sampled points (0.558) was found and this could be responsible.

With respect to Nitrogen dioxide (NO_2), the results in Table 3.3 show that the mean concentrations of NO_2 were elevated at almost all the sampled locations in both dry and wet seasons and in almost all the periods (morning, afternoon and evening). The highest mean concentration found in kasuwan gwari. The highest concentration of NO_2 in Kasuwan gwari was attributed to high vehicular density, traffic congestion as a result of bad road conditions, diversion into kasuwan gwari and stationary combustion emissions from running generators as observed during the sampling. The records were found to be above the NESREA safe limits of 0.04 ppm (I-hour limit) and 24-hours limit of 0.06 ppm in both seasons.

This finding corresponds with the findings by Maitera et al. (2018) who reported that the concentration of NO_2 was also found to be above the safe limit set by NESREA in Yola metropolitan area. The concentration also found higher when compared with 0.043 ppm – 0.078 ppm reported for Aba metropolis, Nigeria (Ideriah et al., 2001). The finding also found similar to Okunola et al. (2012) who found that the concentration of NO_2 exceeds the safe limit of 0.20 ppm – 1.08 ppm reported in Kano, Nigeria (Okunola et al., 2012). The result finding is also similar to the finding by Ibe et al. (2017) who reported that the mean NO_2 in all the air quality monitoring locations exceeded the Nigeria National Ambient Air Quality standards set by NESREA, ranging between 0.20 ppm – 0.70 ppm, except the concentration level at Umuago junction. The finding of this study found that the NO_2 air quality status for all four sampled points was unhealthy. People who work or live at that proximity live in an unhealthy environment, posing a health concern to the public.

Nitrogen dioxide is one of the most active photochemical species and is an essential participant in the smog formation process. It can combine with Oxygen and water vapour to form acid rain. In combination with hydrocarbon in the atmosphere, the oxide of Nitrogen may form photochemical oxidants, which irritate the eyes and respiratory tracts and can easily affect human health (Maitera, 2018). NO_2 is primarily gets in the air from the burning fuel. It forms from emissions from cars, trucks and buses, power plants and off-road equipment, and it can be formed indoors when fossil fuels like natural gases or wood are burned and used in residential areas. This could justify the Pearson correlation test conducted which reveals a weak correlation at 0.05 confidence levels between the mean NO_2 and the average traffic volume (0.169) at all the sampled locations.

With respect to sulfur dioxide (SO_2), the results in Table 3.3 indicated that the mean concentration of SO_2 was also elevated above the safe limit set by NESREA air quality standards limit of 0.01 ppm in all four locations at different sampled points. The mean concentration was ranged from 0.07ppm – 0.024 in all locations both in dry and wet seasons at various locations. Jimeta shopping complex recorded the highest mean concentration of SO_2 within the four sampled points. This could be attributed to the combustion of sulfur-containing fuel vehicles, power generators and the burning of refuse as energy sources among other factors, as the area is a combination of commercial and residential settings.

The research findings correspond with the findings by Modinah et al. (2019) along Ilorin – Lagos expressway, who found that SO_2 measured using Altair 5x multi-gas sensor, they were found above the NESREA permissible limit at all sampled points. While for SO_2 measured using a Gilair-3 air sampler, was also found above the NESREA lower limit but did not exceed the upper safe limit at all sampled sites. The research finding has differed with Ibe et al. (2017) who found that the concentration of SO_2 level was within Nigeria's NAAQS limit but above US NAAQS in all sampled points in Urlu, southern Nigeria. The mean concentration of SO_2 in this study was lower than the ranges of 3.21 ppm – 5.18 ppm, 7.4 ppm – 15.5 ppm and 16 ppm – 64 ppm as reported in similar studies conducted by Ayodele and Abubakar (2010) and Ettouney et al. (2010) in Lagos and Port Harcourt respectively and above the range of 0.03 ppm – 0.09 ppm reported in Kano metropolis, Nigeria (Okunola et al., 2012).

The above findings of this research show that the air quality status in almost all the sampled locations was moderately unhealthy and unhealthy, especially for vulnerable groups (children, elderly and sensitive groups). This also means that if a person inhales these pollutants can easily experience health-related problems. There will be more serious health concerns for the public working or living within the areas. The primary source for the anthropogenic emission of SO_2 into the atmosphere is a combination of the burning of fossil fuels, biomass and emissions from cars, trucks, buses, power plants and off-road equipment (Rahman et al., 2019). This could also prove the result of the Pearson correlation test (0.05) conducted which shows a negative significant relationship at 0.05 confidence levels between the mean SO_2 and average traffic volume (- 0. 572) at all sampled points.

From the results obtained, the concentrations of gaseous pollutants in the dry season were found to be slightly higher than the concentrations in the wet season. The result is contrary to Mohammed and Caleb (2014) who reported elevated concentrations of air pollutants in the wet season over the dry season. But the result corresponds to that reported by Gobo et al. (2012) where higher concentrations of air pollutants were obtained in the dry season. The result is also similar to Maitera et al. (2018) who reported higher concentrations of NO_2 and CO in the dry season over the wet season in Yola metropolitan area. The high values in the dry season might be attributed to the temperature invasion, wind speed, wind direction, heat and low relative humidity. Temperature invasion limits the vertical circulation of air result in air stagnation and trapping of gaseous pollutants in those locations. Humidity is also responsible for the high level of pollutants in the dry season. However, slow wind conditions in the dry season give rise to building up high concentrations of pollutants.

The result in Table 3.3 shows that the average traffic volume was elevated in the morning and evening, and slightly declined in the afternoon in almost all four sampled stations. The finding also shows that the highest average traffic volume was recorded at Jimeta main market gate while the lowest average traffic volume was recorded at Mubi roundabout. The average traffic volume was in the following order: Jimeta main market gate > kasuwan gwari > shopping complex gate > Mubi roundabout. This finding was concord with the findings of the research conducted by Rajini et al. (2009) and Okunola et al. (2012) who reported that the concentration of traffic was higher in the evening and slightly declined during the morning period and drops during the afternoon periods.

5.0 The Relationship between the Air Pollutants and Traffic Volume

In order to determine the relationship between the pollutant concentrations and traffic volume at the four sampled points, Pearson correlation test was conducted and presented in Table 5.1. The Pearson correlation analysis was conducted to see whether there is no significant relationship between the pollutant (CO, NO_2 and SO_2) and the traffic volume.

The Pearson correlation test at 0.05% significance level result revealed a moderate positive correlation between CO and traffic volume (r = 0.558). This shows that the two variables were moving in the same direction; the higher the traffic volume, the higher the pollutant concentration and vice versa. This indicates that the pollutants are primarily from traffic-related emissions. The test revealed a weak positive correlation between NO_2 and traffic volume (0.169). Also, the test conducted revealed a moderate negative correlation between SO_2 and traffic volume (- 0.572). This shows that the two variables were moving in opposite directions. Based on the above result, it clearly indicates that the pollutants were not primarily from traffic-related emissions. We therefore accept the null hypothesis (H_0) that there is no correlation between the air pollutants and traffic volume. This research finding has differed with Oludare et al. (2016), which also found a positive correlation between the parameters (NO, NO_2, SO_2 and CO) and traffic volume, r = 0.613, r = 0.513, r = 0.140 and r = 0.534 for NO, NO_2, SO_2 and CO respectively. Showing that, the pollutants are primarily from traffic-related emissions.

Table 5.1: Pearson Correlation of the Air Pollutants and Traffic Volume

Parameters	**Traffic Volume**	**CO**	**NO_2**	**SO_2**
Traffic Volume	1			
CO	0.558	1		
NO_2	0.169	0.908	1	
SO_2	-0.572	-0.932	-0.857	1

Source: Author analysis, 2023

6.0 Conclusion

The study assesses the contribution of motor vehicle emissions to air pollution in Jimeta metropolitan area. Adamawa State, Nigeria. The finding of this study reveals that air quality status with respect to NO_2 and SO_2 in almost all the sampled points and at all the sampled periods were unhealthy and were found to be far above the NESREA safe limits in both dry and wet seasons in many locations, at different sampled points. This posed a health concern to the public residing or working within the area. It indicated that if a person inhales these pollutants can easily experience health-related problems. The study also revealed that the air quality status in terms of CO is healthy with little or no health concerns to the public working or residing in the area, except for some locations like Jimeta main market and Kasuwan gwari in the morning and afternoon periods in both dry and wet seasons which were found to be slightly above the NESREA safe limits. This raised some health concerns about the quality of the air and its adverse effect on public health in these two locations. A correlation analysis conducted has revealed insignificant positive correlation between CO and NO_2 and traffic volume and also shows negative correlation between SO_2 and traffic volume. This indicates that the pollutants were not primarily from traffic-related emissions.

The study therefore recommends that there should be concerted efforts towards developing and promoting the use of alternative fuels, regular maintenance of vehicles, rehabilitation and expansion of roads. Motorization growth should be largely checked by encouraging mass transit patronization. There is also a need to establish and strengthen the health-based standard for air pollutants. This standard should protect public health including sensitive populations such as children, elderly persons and people with asthma and other respiratory diseases.

7.0 Acknowledgement

The authors must sincerely acknowledge and appreciate the effort of the Tertiary Education Trust Fund (TETFund) for sponsoring this research work under its Industrial Based Research (IBR) grant with the mission of promoting researches among academics in public tertiary institutions in Nigeria. We would not forget to appreciate the effort of the Rector, Adamawa State Polytechnic Yola and the entire management of the institution, the Director, TETfund IBR of the institution, the Laboratory, Adamawa State Ministry of Environment for providing the air quality monitoring equipment and technical assistance during the field work and finally, the research assistants who participated in the data collection.

Reference

Abam, F. I., & Unachukwu, G. O. (2015). Vehicular Emissions and Air Quality Standards in Nigeria. European Journal of Scientific Research, 34, 550-560.

Adebayo, A. A., & Zemba, A. A. (2020). Climate in Adebayo, A. A., Tukur, A. L., and Zemba, A. A. (2020) (2nd edition), Adamawa State in maps, Department of Geography, MAUTech, Yola and Paraclete Publishers, Yola, Nigeria, pp. 31-36.

Adebayo, A. A., Zemba, A. A., Ray, H. H., & Dayya, S. V. (2012). Climate Change in Adamawa State, Nigeria: Evidence from Agro Climatic Parameters. Adamawa State University Journal of Scientific Research (adsujsr) Vol. 2 (2).

Aliyu, I. A., Yusuf, A. A., & Abaidoo, R. C. (2013). Response of grain legumes to rhizobial inoculation in two savanna soils of Nigeria. African Journal of Microbiology Research, 7(15): 1332-1342

Aminu, L., & Ibrahim, N. (2015). Appraisal of Municipal Solid Waste Management (MSWM) in Jimeta-Yola Adamawa state of Nigeria: The need for Innovative, PPP trategies, *Jurnal*

Teknologi (Sciences and Engineering) 77:15 (2015) 93–102, www.jurnalteknologi.utm.my | eISSN 2180–3722 |.

Annual International Conference of Chemical of Nigeria (SCN) at Uyo, Akwa Ibom State, Nigeria, 7th – 12th September, 2014. I, 38 – 44.

Asheshi, O. O. (2012). Measurement of Traffic Emission in Lafia Metropolis, Nigeria. Journal of Science and Multidisciplinary Research, Centrisi Publications. www.centrisinpub.org.

Brezzi, M., & Sanchez-Serra, D. (2014). Breathing the Same Air? Measuring Air Pollution in Cities and Regions. OECD Regional Development Working Papers, 2014/11, OECD Publishing. http://dx.doi.org/10.1787/5jxrb7rkxf21-en.

Ettouney, R. S., Abdul-Wahab, S. A., & Elkilani, A. S. (2009). Emissions Inventory, ISCST, and Neutral Network Modelling of Air Pollution in Kuwait. International Journal of Environmental Studies. 66(2), 193-206.

Gobo, A. E., Ideriah T. J. K., Francis, T. E., & Stanley, H. O. (2012). Assessment of air quality and noise around Okirika community, River State, Nigeria. J. Appl. Sci. Environ. Manage. 16(1), 75-83.

Gulliver, J., & Briggs, D. (2011). STEMS-Air: A simple GIS-based air pollution dispersion model for citywide exposure assessment. *Science of the Total Environment.* 409(12), 2419-2429.

Hassan, S. M., & Abdullahi, M. E. (2012). Evaluation of pollutants in ambient air; A case study of Abuja, Nigeria, Int. J. Sci. and Research 2(12), 1-9.

Ibe, F. C., Opara, A. I., Njoku, P. C., & Alinnor, J. I. (2017). Ambient Air Quality Assessment of Orlu, Souther Nigeria. Journal of Applied Sciences. ISSN 1812-5654. DOI: 10.3923/jas.2017.441.457.

Ideriah, T. J., & Stanley, H. O. (2008). Air quality around some cement industries in Port Harcourt, Nigeria. Sci Afr [Internet]. December [cited 2017 Feb 15]; 7 2: 27– 34.

Kim D., Lee J., Song C.K., Kim S., Ma Y., Lee K., Cha J., & Lee S. (2015). Temporal and spatial distribution of tropospheric NO_2 over Northeast Asia using OMI data during the years 2005–2010 Atmospheric Pollution Research 6, 768–777.

Maitera O. N, Louis H., Emmanuel Y. Y., Akakuru O. U., & Nosike E. I. (2018). Air Quality Index of CO and NO2 in Ambient Air of Jimeta/Yola Metropolis, Adamawa State, Nigeria. Advances in Analytical Chemistry 2018, 8(1): 1-5. DOI: 10.5923/j.aac.20180801.01.

Mauss, E. A. (2017). Childhood Lead Poisoning Prevention: The Tortuous Trail from Human Health Impact Assessment to Effective Environmental Policy. Environmental Impact Assessment Review, 14, 403-423. https://doi.org/10.1016/0195-9255(94)90010-8

Modinah, A. O. A., Kamaldeen, O. A., & Olanrewaju A. A. (2019). An Assessment of Vehicular Emissions and Related Health Impacts along Ilorin-Lagos Highway in Nigeria. Annals of Science and Technology - B, Vol 4 (2). An Official Journal of the Nigerian Young Academy. ISSN: 2 544 6320.

Mohammed, Y., & Caleb, J. J (2014). Assessment of some air pollutants and their corresponding air quality at selected activity areas in Kaduna metropolis.

Nkwocha, A. C., Ekeke, I. C., Kamalu, C. I. O., Kamen, F. L., Uzondu, F. N., Dadet, W. P., & Olele, P. C. (2017). Environmental Assessment of Vehicular Emission in Port-Harcourt City, Nigeria. International Journal of Environment, Agriculture and Biotechnology, 2, 906-911.

Okunola O. J., Uzairu A., Gimba C. E., & Kagbu J. A., (2012). Assessment of Gaseous Pollutant along High Traffic Roads in Kano, Nigeria, International Journal of Environment and Sustainability, 1 (1): 1572 – 1590.

Oludare, H. A., Olasumbo O., & Tope-Ajayi O. O. (2016). Mapping of Traffic-Related Air Pollution Using GIS Techniques in Ijebu-Ode, Nigeria. Faculty of Geography UGM and the Indonesian Geographers Association Journal. ISSN 0024-9521. IJG Vol. 48 No.1, June 2016 (73 - 83).

Rahman, A., Luo, C., Khan, M. H. R., Ke, J., Thilakanayaka, V., & Kumar, S. (2019). Influence of atmospheric PM2.5, PM_{10}, O_3, CO, NO_2, SO_2, and meteorological factors on the concentration of airborne pollen in Guangzhou, China. *Atmospheric Environment*, 212(2), 290–304.

Suh, H. H., Bahadori, T., Vallarino, J., & Spengler, J. D. (2017). Criteria Air Pollutants and Toxic Air Pollutants. Environ Health Prospect, 108, 625-633. https://doi.org/10.1289/ehp.00108s4625.

The World Health Organization, available at: http://www.who.int/publications/cra/chapters/volume2/1353-1434.pdf.

United States Environmental Protection Agency (2017). Nitrogen Dioxide (NO2) Pollution. https://www.epa.gov/no2_pollution/basic_information_about_no2#what_is_NO2.

WHO, (2000). Air quality Guidelines for Europe, World Health Organization Regional Office for Europe, Copenhagen.

WHO, (2011). Air quality and health. Available at: http://www.who.int/mediacentre/factsheets/fs313/en/ [Accessed 22 December 2014].

WHO, (2019). Air Pollution. WHO. Available online at: http://www.who.int/airpollution/en/ (accessed October 5, 2019).

Zemba A. A., Mohammed, M. S., & Ishaku, H .T. (2013). Population density and vegetation fraction as indices for urban land cover classification in Jimeta, Nigeria. International

Journal of Environment Ecology, Faily and Urban Studies (IJELFUC) ISSN 2250-0065
Vol. 3 Issue 2, Jun 2013, 79-86 (C) TJPRC pvt. Ltd.